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Research Study 69-7

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**BESRL'S FIELD-LABORATORY STUDIES IN
HUMAN PERFORMANCE EXPERIMENTATION**

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Night Operations,
Monitor Performance

(14) BESRL Research Study 69-7

(6) BESRL'S FIELD-LABORATORY STUDIES IN
HUMAN PERFORMANCE EXPERIMENTATION

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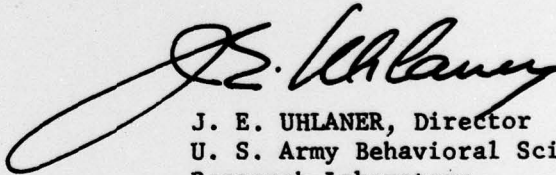
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FOREWORD

The human performance experimentation effort of the U. S. Army Behavioral Science Research Laboratory involves the study of behavioral functions that are common to classes of systems. The aim is to discover general principles which, when applied operationally, will enhance the performance of individuals within the systems. The research typically results in improved work methods, operating procedures, supervisory techniques, and enhancement of man-machine performance. Those means of improving performance which in laboratory studies are found to be successful are evaluated in an operational setting through field research.

The present publication summarizes progress in human performance experimentation in two on-going work units within the Combat Systems Research Division: 1) Human Performance Experimentation in Night Operations and 2) Dependable Performance in Monitor Jobs. Two other work units are in operation within the Division. The first, Dependable Performance in Controller Jobs, like the NIGHT OPERATIONS and MONITOR PERFORMANCE research, is conducted under RDT&E Project 2Q024701A723, "Human Performance in Military Systems," FY 1969 Work Program. The other, Response Systems in Human Performance, falls under RDT&E Project 2Q014501B74B, "Basic Research in Behavioral and Psychological Sciences," FY 1969 Work Program.



J. E. UHLANER, Director
U. S. Army Behavioral Science
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BESRL'S FIELD-LABORATORY STUDIES IN HUMAN PERFORMANCE EXPERIMENTATION

BRIEF

Requirement:

To develop principles *are being developed for* of behavior and man-machine interaction important in selected combat systems. Current specific objectives include raising the level of human performance in ~~1) night operations~~ and in ~~2) monitoring communications and signal identification and analysis.~~

Progress to Date:

NIGHT OPERATIONS. A field research program has been established at CDCEC, Fort Ord, operating in conjunction with BESRL's laboratory facilities. Highly specialized experimental methodology has been developed by BESRL research scientists as a product of preliminary field study of night operations at Fort Benning. Through applications of these techniques, operational data have been obtained which are useful as a basis for establishing procedures and for improving search and scanning performance in night operations.

BESRL research scientists have developed a mobile automated on-line data recording system which has been adopted by the Night Vision Laboratories at Fort Belvoir and by CDCEC at Fort Ord. The computerized system provides rapid feedback of findings to military users as well as a data base on search behavior for more exhaustive analysis.

A procedure was established for setting the dioptral adjustment of the eyepieces to minimize eye fatigue while maximizing seeability. The procedure proved to be very successful.

MONITOR PERFORMANCE. One of the determinations from research on communications monitoring is that repeated transcriptions of a message by a single operator results in substantial improvement in accuracy. Another is that the operator's confidence in his transcript is a good indication of its accuracy--a finding which aids the decision maker in ascribing appropriate weight to a transcribed message. Based on research in special devices search and analysis, specific recommendations have been made for changes in procedures, training, and equipment which have been found to reduce or even eliminate certain measurement errors; and a work method has been developed which would allow personnel to operate in an expanded role under combat conditions.

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BESRL'S FIELD-LABORATORY STUDIES IN HUMAN PERFORMANCE EXPERIMENTATION

When the Army is introducing innovations in a system or changing over from one system or subsystem to another, effective means of evaluating the changes are an imperative need. What concerns behavioral science is the impact on the performance of the human element in the system. In assessing this impact, the development of quantifiable and reliable measures of human performance as it affects systems output is crucial. In the Combat Systems Research Division of the U. S. Army Behavioral Science Research Laboratory (BESRL), such measures are developed through an iterative field-laboratory research program. In such a program, operational problems and hypotheses are first identified in the field. Problems are then simulated and investigated in the laboratory where scientific controls can be maintained. The principles established in the laboratory are further checked by experimentation in a field environment.

The two research programs described below are representative of the Division's application of the iterative field-laboratory approach in two different areas having Army-wide applicability.

RESEARCH IN NIGHT OPERATIONS

An increasing need to improve the Army's night operation capabilities has led to the development of devices which enhance night-seeing ability and aid in the acquisition of targets at night. A primary research effort has been directed toward achieving the engineering requirements for these devices; the human factors problems relating to use of the devices have been given inadequate attention. Human performance experimentation is now sorely needed to determine the level of human performance with the current generation of night vision devices, to determine how to raise this level, and to provide human performance data applicable to the use of future generations of such devices. The major questions to be answered are: Who should use which devices? How and under what conditions should they be used? What should be the basis of issue and mix?

During early 1967, under BESRL'S NIGHT OPERATIONS Work Unit, an exploratory study was conducted at Fort Benning to determine salient variables and parameters related to successful human performance in the use of passive night vision devices. The field study also served to develop techniques, methodology, and instrumentation for future experimentation in night operations.

As a consequence of the exploratory study at Fort Benning, a BESRL research program under CDC sponsorship was set up at CDCEC, Fort Ord, California. The program at CDCEC was initiated in the interest of expanding the contribution of behavioral science to the effectiveness of

night combat operations. Research was needed to supply military managers with basic human performance information which would aid them in making more effective decisions relative to operations and equipment development and in changing concepts, doctrine, and tactics as necessary to meet the aims of increased tactical capability for sustained operations.

The initial phase of the BESRL research program at CDCEC was to observe and evaluate the relative performance of enlisted personnel with four passive night-seeing devices (Starlight Scope, PVS-2; Miniscope, PVS-3; Crew-served Weapon Sight; and the Night Observation Device, Medium Range). The purpose has been to determine how performance is affected by target environmental factors (for example, type, movement, distance, and contrast of target) under various conditions of ambient illumination. In addition, such factors as search behavior, prolonged activity, and performance with combinations of devices have been examined to determine implications for optimal operations.

In the BESRL experimental procedure employed, enlisted participants (players) provided by CDCEC are given 90 minutes of practice, followed by a four-hour test during which, except for short breaks, the players are required to go through continuous search operations. Two measures of human performance are used: percent of target presentations detected and median time taken to detect a target. The resulting data are examined in terms of relative values, since the absolute values reflect performance for specific targets and terrain. Large differences in performance have been found for the different devices and for varying levels of ambient illumination. The findings on relative performance with single devices and with combinations of devices have important systems implications for such problems as basis of issue and mix.

Failures in target acquisition attributable to device as opposed to operator factors are determined by comparison of performance under free search with that obtained by placing the sight reticle on the target and having the player report the instant he sees the target disappear from view. This procedure provides a measure of target "seeability." Search scores lower than seeability scores indicate the difficulty encountered because of the search procedures used by the players. On the average, using the instruments provided, less than half the seeable targets are found during search. This finding implies that improved capabilities leading to the rapid detection of targets are possible.

BESRL scientists have developed a mobile, fully automated on-line magnetic tape system to record automatically, in real time, the target acquisition responses and search behavior of multiple "players" in the experiments. Data obtained can be analyzed by computer for rapid feedback of information to military users and provides, as well, a magnetic tape library of search behavior for more exhaustive analyses.

One fallout benefit of this BESRL effort is that it provides a methodology and experimental instrumentation for larger applied studies that might be conducted by CDCEC. Hence, similar systems are being ordered by the CDCEC and by the Night-Vision Laboratories at Fort Belvoir, Virginia.

Prolonged use of night seeing devices will be common in an operational setting. Data, therefore, are analyzed to determine if changes in level of performance occur over time. No meaningful difference has been found, in the early data, between performance at the beginning compared to performance at the end of the testing period, indicating that with correct dioptral setting for the eye-piece and with proper motivation, it is possible to have little fatigue or vigilance decrement during extended periods of surveillance duty. In terms of soldier capability, this finding has implications for operational utilization of night-vision devices as well as for subsequent experimentation.

The findings cited are a sample of results of the initial phase of the BESRL program. More information is being gathered on search techniques, work methods and procedures, and operational deployment, including size of the search area. With the continued support of CDCEC, the experimental studies of BESRL for the Army Chief of Research and Development, in response to CDC requirements, will be concerned with active and passive ground and airborne night-vision systems, high gear systems, and visionic systems. The primary human response criteria are target acquisition and target acquisition time.

Variables under study include ambient conditions (illumination, weather), type of acquisition (detection, recognition, identification), target characteristics (type, location, distance, movement, contrast), operator characteristics (visual acuity, experience, search behavior), and terrain characteristics (degree of clutter, size of search area). Further comparisons of relative performance with selected devices are made to determine target acquisition variance or failure attributable to device factors and to operator factors.

Emphasis is given to enhancing performance through the development of individual work methods and team procedures. Current and projected investigations include research on work cycles, search techniques, the optimum combination of sensors under various conditions, and the effects of continuous (day and night) operations and prolonged (night only) activity on vigilance, fatigue, and sensory discrimination, with and without devices.

MONITOR PERFORMANCE RESEARCH

As military systems become more complex, man's role in these systems inevitably changes. To a large extent at present, and even more in the future, the routine and programable aspects of systems operations will be assigned properly to the machine. Man's functions will be restricted

to those aspects which require his unique combination of capabilities: a very wide-band set of sensors for acquiring information as well as a remarkably compact and efficient memory and rapidly reprogrammable "computer". These capabilities give the human being an unparalleled flexibility and versatility for action and for adjustment to novel or unexpected situations.

In no aspect of system operation is this versatility more needed than in monitoring. The monitor must continuously be alert to sense stimuli or signals providing information on the external environment of the system as well as its internal environment. These signals may be of many different types, involving different senses, different types of displays, different kinds of characters, and different locations. The monitor must discriminate among these signals, which are often highly complex patterns involving multiple stimulus dimensions and deeply imbedded in "noise". He must interpret the signals (i.e., categorize them on the basis of their effect rather than their appearance, filtering and selecting the ones requiring response) and route this information to the appropriate user/controller.

These requirements tax the human operator to the utmost. Fundamental knowledge of man's perceptual, discriminative, and cognitive capabilities and limitations, under normal as well as emergency conditions, has not been developed to a degree which permits either adequate application to immediate operational problems or the establishment of rules and guidelines for design of future systems. Most of the past research on these problems has been either too specific to a single system, neglecting the broad and fundamental questions involved, or too general to be applicable to the needs of existing and of projected systems.

The research approach of the MONITOR PERFORMANCE Work Unit is dictated by the considerations outlined above. For greatest efficiency, considering both the requirements for answers to existing problems within reasonable time periods and the need for establishment of fundamental principles applicable to future system development, MONITOR PERFORMANCE research is based upon an intensive analysis of human functions in existing systems and identification of critical behavioral factors common to a class of present and near-future systems. This technique establishes the broad guidelines and insures that the research undertaken is truly relevant and widely applicable to Army needs. To insure immediate operational utilization of the research findings, the actual variables and associated parameters selected for experimental manipulation are derived from current systems of the sponsor, the Army Security Agency, and other Army "user" agencies.

This approach is exemplified by the research undertaken in the area of communications. The tactical effectiveness of a combat unit is greatly dependent on the flexibility, speed, and accuracy of the communications on which it relies for information concerning plans, activities, and capabilities of friendly and enemy forces. Thus, the efficient performance of communications personnel in extracting and reporting infor-

mation from such communications is a matter of great importance. For this reason, research was undertaken by BESRL to determine optimum work methods and procedures for enhancing the performance of communications monitors. One group of studies investigated the effects of repeated transcription, by one or more operators, on accuracy of transcript. It was found that repeated transcriptions by an individual operator resulted in substantial improvement in accuracy. However, the use of multiple transcribers was not justified on a cost-effectiveness basis, except perhaps on messages of marginal or less-than-marginal intelligibility or when conditions were critical. A second group of studies dealt with the ability of transcribers to rate the accuracy of their own transcriptions. It was found that the operator's confidence in the accuracy of his transcript was a good indication of transcript quality. This finding can be of importance to the decision maker in determining the relative weight to be placed upon the transcript message in relation to information from other sources.

Research has also been undertaken in special devices search and analysis. While all of this research is classified, it can be discussed in general terms. The initial examination of this area revealed that the speed, accuracy, and judgment of personnel assigned the task of locating, measuring, and analyzing signals were of critical importance. Research was undertaken to determine the relative usefulness of various signal parameters in identifying signals, and to determine the degree of success of personnel in measuring and reporting these parameters. As a result of this research, the incidence of certain types of measurement errors was found to be an important factor in the incorrect identification of signals, and specific recommendations were made to reduce or eliminate most of these errors. These recommendations included proposed changes in operating procedures, training, and equipment.

A work method was also developed by BESRL which would allow personnel to operate in an expanded role under combat conditions. When this method was compared with two existing work methods, it was found to be superior on a number of measures. HQ, USASA felt that these findings justified a full field trial. Such a trial was conducted in Europe by BESRL scientists. The results indicated that the BESRL technique was accepted by operators as a quick, usable, and accurate work method. It was also considered a useful device for on-the-job training.

After review by the HQ, USASA, the reports of these investigations were referred to NSA for review and comment. NSA considered the research valuable and recommended that some of the specific recommendations by BESRL be implemented. On the basis of this research, NSA has invited BESRL's participation in further work in this area.

